Seamless Integrated Network System for Wireless Communication Systems

FIELD OF THE INVENTION

The present invention relates to a system that can seamlessly integrate and efficiently utilize various wireless communication systems. In particular, the present invention relates to a technique of providing a common platform for various wireless communication networks in such a system.

BACKGROUND OF THE INVENTION

Many specific proposals have been made regarding fourth-generation mobile communications which is to follow third-generation mobile communications, the introduction of which is near at hand. For example, fourth-generation mobile communications may enable mobile computing services featuring optimum connections up to a hundred megabits per second, regardless of location. If such communication is a mere extension of the current terrestrial system, high-speed services will be limited to specific areas (e.g., hot spot services). Thus, services at the minimum required transmission speed may be provided over wide areas, whereas high-speed transmission services may be provided in hot spots.

However, it is difficult to use a single radio system to provide services corresponding to various transmission speeds or QoS (Quality of Service: technology that optimally assigns bands in accordance with the purpose of communication to ensure proper response time and throughput required for communication), regardless of whether the services are provided in real time or accumulated.

Thus, in view of the conventional problems, an object of the present invention is to construct a plurality of wireless

communication systems into systems that are optimum for corresponding environments and thereby create a network that can seamlessly integrate the resulting systems in order to provide generally more efficient advanced services.

In particular, the present invention provides a common platform for various radio communication networks.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an explanatory diagram comparing several network structure models; Fig. 2 is a conceptual drawing of the structure according to the present invention; Fig. 3 is an explanatory diagram showing the architecture of a heterogeneous network according to the present invention; Fig. 4 is an explanatory diagram showing the configuration of the common core network according to the present invention.

Identification of reference numerals used in the drawings is as follows: 30 Base Station, 31 Common Core Network, 31 Global Core Network, 32 Gateway Router, 33 Internet.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

To achieve the above object, the present invention uses the following means:

In a network system that seamlessly integrates wireless communication systems, a common core network providing a common platform for a plurality of radio communication networks comprises a mobility manager that supports roaming mobile hosts and a resource manger that coordinates traffic distribution.

The common core network allows roaming within a homogeneous radio communication network and between heterogeneous radio communication networks while ensuring service quality, and in one area, enables

Internet access via a gateway router and access to a base station via a base station interface. A plurality of common core network structures, each of which is the same as that residing in one area, are each arranged in a corresponding area via the Internet.

This system may have a micromobility management function supporting, in one common core network, prompt handover for any mobile host roaming between base stations belonging to homogeneous radio communication networks or between base stations belonging to heterogeneous radio communication networks or between routers, and a macromobility management function supporting, between a plurality of common core networks, handover for any mobile host roaming between base stations belonging to homogeneous radio communication networks or between base stations belonging to heterogeneous radio communication networks or between routers.

An embodiment of a seamlessly integrated network system for wireless communication systems according to the present invention will be described below. The embodiment is not limited to the one described below but may be arbitrarily changed without deviating from the spirit of the present invention.

The present invention constructs a system based on a heterogeneous network, which is under development. A model of this network will be described.

There are several architectures applying a plurality of different WANs (wireless access networks) in a heterogeneous network model. The basic models are illustrated in Fig. 1 by two WANs, network A and network B. The main distinction between these models is the layer on which the WAN communicate. Many derivates of these models are possible (see for example Tonjes, R. et al.: "Architecture for Future Generation Multi-access Wireless System with Dynamic Spectrum Allocation", Mobile Summit 2000. Galway, Ireland, 1-4. October 2000,

http://www.ist-drive.org/papers.html.).

In model A, or a tunneled network (10), a user has a service agreement with operators of several WANs independently.

Based on some policy, the optimal network for the requested service is selected. The hybrid core (11) tunnels the traffic across the Internet (12), and the selected access network (13) to the mobile host (14).

Connectivity between networks is based on relatively higher network layers (e.g., transport layer) of seven-layer OSI model, resulting in increased service latency.

This system requires no modification to existing access networks. Moreover, they all have their own infrastructure, e.g., signaling, handover, and billing. This makes it very difficult for existing network systems to cooperate efficiently.

Model B, a hybrid network (15), is provided with a hybrid core (16) that interfaces directly between a WAN (18) and the Internet (17).

In this model the WAN (18) implements the network layer and below. Advantages are that in the model there will be less duplicate functions, and that it is able to offer advanced services at the network or data link layer (e.g. it can provide a better handover between the WANs).

Model C, a heterogeneous network (19), has a common core network CCN (20) that deals with all network functionality and operates as a single network. Different WANs (21), (22) handle only those functions specifically related to a distinct radio access technology.

In general the wireless access radio incorporates the physical and data link layers only.

Communication between WANs belonging to the CCN (20) is based

on a lower network layer (a link layer or network layer) of the OSI model.

This reduces the overhead, and improves performance. A major challenge of this model is that the different WANs should converge, which requires a standardization effort and business commitment to support it.

The present invention is characterized in that the hybrid and heterogeneous networks are mutually distinguished. In general, various kinds of structures are often collectively referred to as "hybrid," but in the present invention, these structures are called "heterogeneous" to stress the fact that a plurality of access networks are simultaneously present and cooperate with each other.

The hybrid network corresponds to the conventional concept that one of plural networks is selected for use.

Currently, related work mainly is associated with routing and handoff aspects for wireless networks. The Mobile IP protocol (Perkins C., IP Mobility Support, RFC 2002, October 1996.) supports mobility transparently above the IP level and it allows the nodes to change their location.

Mobile IP is generally seen as a macro mobility solution. It is less suited for micro mobility management, in which a mobile host moves within a sub network.

A typical example of micro mobility is a handoff amongst neighbor wireless transceivers, each of which is covering only a very small geographical area. There have been quite a few proposals to support micro mobility (e.g. Cellular IP; (Campbell A.T., Gomez, J., Kim S., Turany i, Z., Wan, C-Y., Valko, A: "Design, Implementation and Evaluation of Cellular IP", IEEE Personal Communications, Special Issue on IP-based Mobile Telecommunications Networks, Vol. 7 No. 4, pg.42-49, August 2000), HAWAII (Ramjee R., La Porta T.F.,

Salgarelli L., Thuel S., Varadhan K., Li L.: "IP-based Access network infrastructure for next-generation wireless data networks".).

The differences among all these schemes are related to the mechanisms used to route the packets within a local (home or foreign) domain.

Related work on QoS over Internet is mainly based on Integrated Services (Braden, R, Clark, D., Shenker, S., "Integrated Services in the Internet Architecture: An Overview", IETF RFC 1633, 1994.) and Differentiated Services (Blake, S., Black D., Carlson, M., Davies, E., Wang, Zh., Weiss, W., "An architecture for Differentiated Services", IETF RFC 2475, 1998).

Other related research is mainly focusing on hybrid network architectures, or support for macro mobility (Daedalus project, Berkeley, http://daedalus.cs.berkeley.edu.) (Monarch project, CMU, http://www.monarch.cs.cmu.edu.).

Given ATM is able to support QoS, there has been strong interest in developing wireless ATM technologies (e.g. the Magic Wand project, http://www.tik.ee.ethz.ch/~wand/).

Current work merely provides solutions to roaming mobile hosts by supporting protocols for mobility. Heterogeneous networks might be used, but more in the traditional sense of selecting one or the other.

According to the present invention, mobile hosts can communicate not only over a single WAN, but also over a plurality of WANs simultaneously.

The major challenge for the future generation wireless Internet is that the architecture will have to be very flexible and open, capable of supporting various types of networks, terminals and applications.

It is a fundamental object of the present invention to make the

heterogeneous network invisible (seamless) to the user. In addition, a subject is to design the system architecture such that it is independent of the wireless access technology. These considerations lead to the following requirements:

First, a plurality of access technologies are the key to the success of software-defined radio (SDR), and each WAN can be optimized for certain services.

Next, heterogeneous access support is described. In a heterogeneous network it should be possible to use a combination of several networks, each of which is optimized for some particular service. Multiple differentiated flows can then be used to achieve better and cheaper connectivity.

Since it should be possible to use multiple WANs 'simultaneously', the SDR must be able to switch quickly between the various WANs.

For mobility management, seamless handovers are desirably carried out between homogeneous WANs and between heterogeneous WANs or between homogeneous technologies and between heterogeneous technologies. It is contemplated that wireless access technologies may be popularized, ranging from local point-to-point connections such as Bluetooth, which are made via wireless LANs, to first-, second-, and third-generation cellular systems.

The selection of the efficient configuration is also one of the requirements. An important motivation of a heterogeneous network is that it is possible to use a selection of several WANs.

The decision of selecting the most appropriate WAN(s) could be based on aspects like available bandwidth, energy consumption needed to perform the service, service classification, and cost.

The result is that each service is delivered via the network, which is most efficient to support this service.

Simple, efficient, scalable, low cost- all these requirements

are closely related to each other. These requirements are of particular importance in the future pico-cellular networks in which access point offers tens to hundreds of megabits per second. It is not affordable to have many complex access points.

Energy efficiency is also an essential condition. It is generally expected that once wireless IP communication equipment is switched on, services are always accessible through the wireless Internet.

This implies that mechanisms for services like maintaining location information and wireless system discovery should be energy-efficient (and bandwidth efficient as well). Cellular systems employ the notion of passive connectivity to reduce the power consumption of idle mobile hosts.

Mobile systems are open to a number of security problems that do not exist in their stationary counterparts. Mobile hosts must update their location while moving. These location messages make impersonation possible unless properly secured.

In systems and applications in which seamless handoff is given top priority, information on session keys used by the mobile hosts must be immediately available at a new base station or access point during handoff.

In the last condition, it is desirable to be provided with end-to-end QoS mechanism;

Since the WANs provide services that are specialized for some service, QoS aspects in heterogeneous networks are of prominent importance.

End-to-end QoS implies that interoperation with local QoS mechanisms should be possible, but also that lower layer protocols (link and physical layer) should be aware of the traffic characteristics and so be able to meet the different requirements of QoS.

It should be noted that some of these requirements are closely related to each other. Solving the research challenge for one requirement may solve others.

Accordingly, to the maximum possible extend, efforts should focus on constructing structures based on existing protocols to make the existing protocols and applications compatible with each other, while minimizing the required time and labor.

The common core network provides the common platform through which all multi-service terminals communicate with correspondent nodes residing in external networks.

In principal all access points of the WANs are connected to this network. The network provides routing and seamless handovers between the WANs.

In this way a natural integration of the various heterogeneous networks is achieved.

The main functional entity of the CCN is the Resource Manager, which coordinates the traffic distribution, and selects the WAN. It has a common database for managing users' profiles with entries like authentication, preferred access system, billing, policy, users' terminal capabilities, etc.

The structure according to the present invention provides communication between mobile hosts and correspondent nodes residing in external networks. Fig. 2 shows a conceptual overview of the architecture. The universal component in this structure is a base station or access point (30) that serves as a wireless access point and interfaces with a CCN (31).

CCNs (31) are connected to the Internet (33) via gateway routers (32). A CCN (31) provides services for several WANs. In general the WANs will overlap, and a mobile host (34) can have access to several WANs at one location. The area covered by these wireless

networks can be quite large.

Macromobility is implemented using a mobile IPv6 in CCN. The CCN with high-speed wireless access with frequent location updates requires micro mobility. Mobile hosts attached to the base station or access point use the IP address of a corresponding gateway as a mobile IP care-of address. Inside the CCN, mobile hosts are identified by their home address. The base station or access point is connected to a regular IP forwarding engine.

Such engines are connected via a network topology that allows packets to be transmitted between the base station or access point and the gateway.

In the present invention, the base station is equal to a wireless access point, but the present invention is not limited to this aspect. Some wireless access providers use their own network, including interconnected access points, and share one base station or access point to connect it to the core network. An important concept of the present structure is a degree of simplification required to implement an inexpensive network. The concept of CCN and separate BAN offers providers of wireless services the possibility to setup an infrastructure with little investments. New providers can easily connect to the core network, provided that they use the correct interface.

They do not need to have their own infrastructure ready before they can start their business, but instead use the infrastructure provided by the core and BAN. All they have to do is to develop their wireless service, and concentrate on the wireless access only.

The infrastructure that is generally needed to setup a whole new service is already provided by the architecture. This involves both technical problems (e.g., a network connecting base stations or access points, and associated routings, handoffs, and Internet

accesses) and business problems (e.g., billing and management of consumer profiles). The components that must be constructed are base stations or access points and an access mechanism for terminals. Typically, the access mechanism may be a software module suitable for use in multi-service terminals.

A consumer may have a contract with the CCN provider, and buy various services (provided by a WAN) from it. If the consumer has a contract that enables him to use multiple services, then the system and the user is able to select the most appropriate service. Access networks may also be combined to increase the available capacity.

Different access networks might also be used for uplink and downlink traffic. This can be advantageous for user applications like web browsing and e-mail, which in many cases are asymmetrical in nature causing more downlink than uplink bandwidth.

The result is that each service is delivered via the network that is most efficient (in many perspectives) to support the service. In effect, the consumer is unaware of the wireless technologies used to provide the service.

Enabling end-to-end QoS over Internet is a tough venture, because it introduces complexity starting from applications, different networking layers and network architectures, but also in network management and business models (IEEE Personal Communications, pp. 34-41, August 2000).

It becomes even more challenging when one is introducing QoS in an environment of mobile hosts, wireless networks, and different access technologies. Yet the need for QoS mechanisms in this environment is greater due to scarce resources, unpredictable available bandwidth and variable error rates. The heterogeneous network, to which different wireless networks with respective characteristics are applied, evidently requires the QoS mechanism.

Within the fixed Internet there are several ways to enable end-to-end QoS. Current work on QoS over IP architectures, i.e. Integrated Services and Differentiated Services seems to leave out mobility support, despite its importance.

The QoS approach can be divided into two parts: core network QoS and fixed network QoS services. In this way, the wireless IP (core) network is compatible with the fixed state-of-the-art QoS solutions. The gateway router provides merely the mapping between the Internet and the core network.

All IP communication is packet based relying on connectionless transmission. The addressing scheme does not enable the system to differentiate traffic flows.

The term traffic flow refers to the flow of IP packets that belong to the same connection, i.e. the IP packets that are sent between particular applications (port) and between particular hosts (IP addresses).

Traffic flows within the CCN are differentiated according to its service needs and QoS requirements. There are two main reasons for having such differentiated traffic flows:

First, these traffic flows are required to implement routings. In the present invention, a mobile host can have a plurality of flows for at least one service use a plurality of heterogeneous WANs. Each access network is used for the kind of service for which it is optimized.

Accordingly, packets for different services transmitted between the mobile host and the corresponding node can use different routes (i.e., different base stations and different access networks) over the CCN. The mobile host can thus simultaneously use at least one base station or access point to connect to the CCN.

The traffic between the mobile host and the base station or access

point must be distinguishable on the basis of required services.

Second, these traffic flows are required to implement cross-layer interactions. In a wireless environment it is essential that the lower layer protocols are aware of the traffic characteristics. The Internet is implemented on the basis of the ISO/OSI hierarchy architecture, where the protocols for different layers are independent of each other.

For the wireless Internet, information on other layers may be required to improve overall performance and efficiency. For example, although the TCP specification contains no explicit reference to the characteristics of the lower layers, implicitly in the timeout and retransmission mechanisms there is the assumption that the error rate is low, and that the lost packets occur due to network congestion.

TCP has no way of distinguishing between packets corrupted by bit errors in the wireless channel from packets that are lost due to congestion in the network. Another example, for designing a wireless MAC and data link protocol, it is more efficient if the traffic characteristics are known in the MAC and data link layer.

Also, in W-CDMA systems, power control can be used to meet the different QoS requirements for different traffic. In other words, they all suppose to be able to know the traffic types even in the physical layer.

These examples attest the need to tailor protocols to the environment they operate in. Separating the design of the protocol from the context in which it exists leads to penalties in performance and energy consumption that are unacceptable for wireless, multimedia applications.

So, differentiating traffic flows is needed and useful. However, a challenging problem is how to detect these flows, and how to determine the QoS requirements for these flows. We can distinguish

two major classes: explicit differentiation by using an application level signaling protocol, or implicit differentiation based on the traffic class.

First, the explicit differentiation should be described. Due to its future potential and advantages, IPv6 is selected as a protocol framework.

An important IPv6 feature is the introduction of flow labels to enable the labeling of packets belonging to particular traffic flows for which the sender requests special handling, such as non-default quality of service or real-time service (Braden, R, Clark, D., Shenker, S., "Integrated Services in the Internet Architecture: An Overview", IETF RFC 1633, 1994).

It is currently not clear what level of granularity will be provided via the flow label. It is likely that many real-time applications will not employ the flow label, yet they want more than best-effort service.

Another issue in this case is to decide what QoS to provide this flow, since no QoS information is provided.

Second, the implicit differentiation should be described. Implicit flow detection can be based on various mechanisms. For example, the Diffserv QoS class can be mapped to the appropriate wireless QoS.

IPv6 also has an 8-bit Traffic Class field in its header. This field is available for use by originating nodes and/or forwarding routers to identify and distinguish between different classes or priorities of IPv6 packets.

At this moment it is not clear how this field will be employed, but there are a number of experiments underway to provide various forms of 'differentiated service' for IP packets, other than through the use of explicit flow set-up (Deering S., Hinden R.: "Internet

Protocol, Version 6 (lPv6), Specification", IETF RFC 2460, December 1998). Alternatively, one could also monitor the transport layer port numbers and forward IP datagrams with WWW or FTP traffic in a non best-effort fashion (Magic Wand project, http://www.tik.ee.ethz.ch/~wand/).

In the present invention, the CCN must contain a mechanism for routing flows to the mobile terminal using an efficient wireless network and a mechanism for exchanging information between the layers in connection with various QoS requirements. Due to the virtues and future potential IPv6 is selected as a protocol framework.

Traffic originating from the external network can be discriminated using either explicit or implicit discrimination mechanisms.

Flow discrimination and routing within the CCN is based on the network layer (i.e. IP). This enables the use of other proposals to support micro-mobility, like HAWAII and Cellular IP. Encapsulation of all datagrams in a new IP datagram within the CCN is likely to be the most appropriate solution.

In the present invention, this method provides a consistent access mechanism, thus eliminating the need to adapt applications or services residing on external networks (without losing the advantages obtained by application of the explicit discrimination mechanism).

An explanation of the functional modules of the structure and protocols employed in the present invention is presented below.

The architecture as depicted in Fig. 3 consists of four major building blocks (40), (41), (42), (43): mobile hosts (40), WANs (41), CCN (42), and external network (43).

Within the external network (43) is the Corresponding Node (CN) (44). One or more Gateway Routers (GR) (45) connects the external

network (43) to the CCN (42).

At the external network (43) Mobile IP is assumed. Here, the gateway router (45) plays an active role. Once tunneled packets reach the gateway destined for the mobile host, the gateway detunnels the packets and forwards them to the base station or access point.

Two important functional entities within the CCN (42) are the Resource Manager (RM) (46) and the Mobility Manager (MM) (47). They are primarily responsible for traffic distribution and mobility related issues.

The CCN (42) supports the communication to the base stations, and thus to the WANS (41). A base station or access point interface (BSI) (49) primarily provides a consistent access mechanism for the base station or access point (48) to the CCN (42). The BSI (49) is a component of the base station or access point (48).

The base station or access point (48) deals with normal link layer problems concerning wireless access and collects status information on the wireless network it supports. The base station or access point (48) uses a network interface (NI) (50) to access the network.

A primary component of a mobile host (40) is the Basic Access Component (BAC) (52) to communicate with the BAN (51). Besides this interface, it also has a Network Interface (53). In contrast to the NI (50) for the base station or access point, the current interface (53) is typically based on software radio technologies and can use a plurality of WANs (41).

A Network Selector (NS) (54) communicates with the Resource Manager (46) to tune the radio for the WAN (41) to use. A Network Selection Control protocol is used to enable the proper selection of the access network.

The Locator (LOC) (55) provides the RM (46) with location

information of the mobile host (40). The Local Resource Manager (LRM) (56) deals with the local resources of the terminal, and interacts with the resource Manager (46) at the CCN (42).

The primary object of the configuration of the present invention is to integrate various access techniques to obtain a common configuration. This integration improves the system's efficiency and makes it easier for mobile users to receive their requested services.

To achieve this object, the current configuration must accomplish the following: resource management that adjusts the distribution of traffic within the system and mobility management that supports roaming mobile hosts.

The RM (46) is thus responsible for resource allocation and admission control to support the traffic distribution in the CCN (42). It selects the wireless access network (WAN), which can provide the requested service of a mobile host (40) in the most efficient way. In essence, it combines multiple WANs, and exploits their specific strength to provide services in a spectrum efficient way (Rexhepi, V., Karagiannis, G., Heijenk, G., "A Framework for QoS & Mobility in the Internet Next Generation", Proceedings EUNICE 2000, Sixth EUNICE Open European Summer School, University of Twente, Enschede, the Netherlands, September 13-15, 2000).

Another task of the RM is to interact with the IP QoS architectures (such as Intserv or Diffserv) that might be used in the external network (43). This only associates internal and external QoS parameters with each other.

The present invention intends to utilize some of the basic classes in the core network CCN (42) (e.g., best effort, real-time, and adaptation). These mechanisms enable radio links to support IP packets with QoS parameters varying to some degree. These functional

modules are implemented in the network layer.

The RM is able to provide the selection by using certain criteria originating from various sources: the mobile host (i.e. the Local Resource Manager), the user, applications, and base stations. Specific inputs are:

(i) QoS requirements of sessions

(ii) User preferences like cost and preferred WAN

(iii) Terminal capabilities like supported access networks, protocols, and available resources

(iv) Status of the CCN and the WAN

(v) Location of the mobile host.

The RM (46) also should incorporate the costs involved in changing the access network (like the costs involved for reconfiguration of the software radio). This management task, however, is by far not trivial, especially not with mobiles that roam quickly through the region.

The MM (47) deals with all mobility related issues. The mobility manager (MM) (47) traces the location of a mobile host to determine an access network effective on the mobile host at the particular location.

The resource manager RM (46) utilizes information from the mobility manager MM (47). Another major task of the MM (47) is to carry out local handoffs within the CCN (42) and handoffs for external networks (based on a mobile IP). For these handoffs, the MM (47) must communicate with the RM (46).

The MM (47) is implemented in the network layer and operates in the CCN (42). When the mobile host (40) moves within the core network, the mobility is invisible to the network layer, and the system attempts to maintain the IP flow and the IPQoS parameters. The mobility between core networks is restricted depending on which

packets can be transferred as best-effort traffic.

The mobile host (40) includes all standard transport protocols and wireless specific control services. The control messages are transparently sent between the core network (42) and mobile hosts' (40) functional entities.

The BAC (52) will be part of any mobile host (40). It is used as the primary component to communicate with the basic access network (51). The BAN (51) is used for various functions including signaling, synchronization, paging, locations, etc. Synchronization is important when the mobile host (40) has the capability to use multiple access networks.

If the network interface (NI) (53) is implemented using software radio technologies, it is impossible to use a plurality of access networks simultaneously (except BAN).

To be able to schedule the access network, a good synchronization mechanism is required. The Network Selector (NS) (54) is the entity that is able to select the required access network.

The network selector (54) communicates with the resource manager RM (46) residing in the CCN (42) to determine the available period for communication with a network to be utilized.

The RM (46) distributes traffic in accordance with the user's choices, the resources of the common core network (42) such as a WAN, and the local resources of the terminal (40). A local resource manager (LRM) (56) processes the local resources of the terminal and communicates with the RM (46) of the CCN (42).

Applications should be able to use the infrastructure and specify its traffic and QoS requirements. A QoS API is used by the applications to specify their needs, and establish a session. If they do not use this API, best-effort mechanisms will be used for their session.

The mobility and QoS managing method proposed by the present invention is compatible with fixed mobile IPv6 network techniques. Furthermore, a combination of these techniques and microcellular mobility solutions enables interaction between fixed network QoS techniques and wireless QoS techniques (corresponding to layers lower than the network layer).

This enables the wireless network to support IP packets with varying IP QoS parameters properly. As the core network QoS and flow management is independent of the deployed IP protocol suite, the system can be enhanced to support alternative IP techniques, such as differentiated services.

Now, the configuration of the common core network according to the present invention, shown in Fig. 4, will be described below. Fig. 4A shows the above described common core network (31; see Fig. 2), and Fig. 4B shows a configuration in which the common core networks (31...) are each arranged in a corresponding one of all areas and are connected via the Internet (33).

In each region, there is a gateway router (32...) between the Internet (33) and regional CCN (31...) to which base stations (30...) of each cell of various wireless systems are directly connected. The global CCN (31') consists of regional CCNs (31...).

The present invention enables the construction of a network that utilizes multiple types of wireless communication systems in a manner optimal for their environments, while seamlessly integrating such systems to provide more efficient and advanced network services in general.

In particular, the common core network according to the present invention supports horizontal seamless mobility within the same radio system and vertical seamless mobility between heterogeneous wireless communication systems, enabling mobile hosts to use the

same IP address.

New services can be easily started by directly connecting access points to the CCN.